The changes in the bones and joints can be realized fairly well from one of the many röntgenographs made by my colleague, Dr. R. D. Carman. The bones show rarefaction as is common in cases of chronic arthritis. Besides the erosion, cupping, and exostosis of the articulating ends, there is the not uncommon change in the shape of the heads of the bones, so that the heads of the humerus and femur, and the condyles of the femur and head of the tibia seem elongated. The shafts of the long bones are unusually thin and slender and the metacarpal bones and phalanges have cupping and broadening of the articular surfaces and narrowing of the shafts, somewhat suggestive of achondroplasia. It seems to me impossible to exclude the latter process, but I present the case without further comment.

THE METABOLISM AND SUCCESSFUL TREATMENT OF CHRONIC JOINT DISEASE: A PRELIMINARY REPORT.

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It is a familiar clinical fact that chronic joint troubles form one of the most frequent and rebellious of diseases. The application of laboratory methods to the diagnosis of the several varieties and the rational treatment dependent upon it have reduced many of these to categories which are fairly well understood and yield good results. Thus the tuberculous, Neisserian, and specific joints tell their own story, but after eliminating them there remains a large class in which but little progress has been made. This is the class grouped by various writers under the headings, rheumatoid arthritis, chronic articular rheumatism, arthritis deformans, and so on, conditions having in common an obscure or doubtful etiology and a prognosis for the most part unfavorable.

The activities of certain workers, particularly perhaps Goldthwaite and his collaborators in this field, have brought some order out of chaos, but it should be noted in passing, and with no credit to the internists and laboratory men, that it remained for orthopedists to suggest the simplest classifications and to practise the most rational therapy. It is due chiefly to the above men, for example, that we recognize in these obstinate cases the importance of a focus of infection in a tooth or tonsil, and that regulation of the diet along broad and intelligent lines is of the utmost value in the undernourished and overfed. And again, we are now aware of the toxic possibilities incidental to a ptosed colon for which abdominal supports and operation have given much relief.

Grouping these cases as a whole, however, and eliminating them in turn from consideration, there remains a large and distressing number of cases which progress from bad to worse despite surgery, good hygiene, overfeeding, and underfeeding.

The principles of treatment as outlined above are now generally observed and practised by careful clinicians, but that they often fail is common knowledge. That the intestinal tract, however, is in some way or other connected with most of these last toxic arthritides is becoming more and more the belief of those who most frequently handle such conditions, but after what fashion it operates or what should be done for relief is not so clear.

In those instances where support for intestinal prolapse is not needed or fails, or where operation is not practicable or successful, there is often recourse to a consideration of diet, and it is partly with this phase of the subject that we wish now to concern ourselves.

More specific and detailed knowledge is obviously needed, and for lack of it, dietary control of these rebellious cases is practically renounced as impossible and not attempted.

The necessity of treating a number of sufferers from the conditions above indicated brought home to the author the desirability of some definite observations by clinical and laboratory methods from which an etiology and treatment could be deduced.

It is advised by many, for example, that in the dietary supervision incidental to good hygiene consideration should be had as to constipation, flatulence, the caloric need of the thin individual and the caloric surfeit of the fat individual, and that only the digestible foods should be eaten, that abundance of water should be ingested, and the like. At last analysis, however, these instructions are too generic, and in application generally fail of their purpose. Specifically stated, to feed these individuals with due regard to their nutritive needs and at the same time to avoid the element or elements which cause the joint disturbances, is the problem which presents.

Having found such a dietary regimen there would be offered thereby an opportunity for study of the processes active for good and evil which might yield facts of the utmost value. Why such a study has not been attempted before is not clear to the writer, since opportunity has at times presented in those cases which have yielded to the correction of intestinal ptoses.

Reference to the literature, however, indicates that while the contributions to chronic joint diseases have been legion, they have rarely been specifically along the lines indicated, and have rarely been accompanied by careful laboratory studies.

It has seemed evident for some time past to the writer that in these joint conditions of intestinal origin several causative possibilities presented. (1) There is to be considered the activity of the intestinal flora *per se*, generally accepted for the most part as putrefactive, whose growth and by-products might cause absorbable toxic matter. (2) There is their action upon the ingested food to be considered, by virtue of which there may occur substances whose absorption might be causative of trouble. (3) There is the possibility of some defect in that disintegration and synthesis which gives rise to the "bau-steine," as a feature of pure physiological or pathological metabolism. How best to control the conditions of experiment to obtain a clue as to which possibility, if any, is operative, must be determined.

The writer has observed in a number of instances the remarkably beneficial effect of purgation and starvation upon the symptoms of certain joint cases, and the question is raised as to whether this be due to the absence of food decomposition and synthesis, to a diminution of intestinal bacterial activity, or to both. That the amount of food *per se* is an important factor apart from its relation to bacterial activity is indicated somewhat by the well-known favorable action of arsenic in these states, one action of which is probably to hasten the general metabolic processes. Another agent capable of this same action, though to a greater degree, is thyroid extract, whose gradual effect on nitrogenous exchange and the persistence of this after administration of the drug has ceased, are testified to by many observers.[1]

It is plain, therefore, that a great reduction of the food intake, active purgation, or the administration of agents which hasten the general body metabolism act beneficially on the symptoms of these conditions. The last mentioned agents, furthermore, are often beneficial even in conjunction with little or no reduction of the ingested food and may even stimulate the appetite to a greater consumption. If we apply the reasoning here suggested it would seem likely that there is a point at which one or all of the elements of food can be assimilated with satisfaction to the body needs and without detriment to any particular structure.

The lesson to be learned is in some respects like that taught by gout and diabetes, though the particular elements harmful in joint disease must yet be determined. An effort was made along these lines, beginning with the simplest of foods in order that the effect of their several component elements might more clearly be observed. Milk suggested itself at once, of course, as a basis for experimentation and our intention at first was to use whole milk. Experience with one case, however, in which "buttermilk" was successfully administered, seemed to urge further trial of it, and more systematic study of the results obtained. The question of the value, if any, of introducing fermentative organisms into the intestinal tract by this means is still *sub judice*, though the observations of Herter and others have indicated the great importance of more work along this line.

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[1] Von Noorden, Metabolism and Practice of Medicine, iii, 991.

There can be very little doubt, however, of the importance of learning the effects in these cases of reducing to a minimum the activity of the usual intestinal bacteria, and the simplest method of achieving this, in some part at least, has been shown to be by frequent movement of the bowels and by colonic lavage.

"Intestinal antisepsis" comes in here for very little consideration because of the discredit into which it has been brought by most observers and because drugs in any event introduce complicating factors. Whether, in this connection, by feeding fermentative organisms in large quantities in the form of buttermilk there can be produced an actual replacement of the customary intestinal flora is a problem whose terms and possibilities are not yet clear. It is worthy of study, however, and offers at least an hypothesis for development.

We desire here to report, therefore, (1) the results of treatment by these means in a series of chronic joint cases, and (2) the results of metabolic study of some of these individuals at certain periods of their progress. This report is to be interpreted, however, as purely preliminary and subject to the results of further study along the same lines. This is now in process, and only because of certain extraneous factors is it deemed advisable to report the results to date.

Case I.—Mrs. M., aged sixty years, in comfortable circumstances and the mother of three healthy grown children, had been accustomed to robust health and rather unusual physical activity. She was first seen January 19, 1911, complaining of "rheumatism" or "gout" in her fingers and knee.

Physical examination revealed swelling and pain of all but the terminal finger joints of both hands, which had been growing progressively worse since the previous August. The second phalangeal joints had suffered the most, compelling her to remove her rings, though the dorsum of the hands was also puffy. Active and passive motion of these joints caused pain, and some of them had limitation of motion. The left knee was also tender on certain forcible palpation and gave considerable pain on walking, causing a limp and curtailing activity. The patient felt somewhat depressed but had no other subjective symptoms. She was rather heavily built, had a chronically slightly coated tongue (a feature common to at least two of her children), and a well audible mitral systolic murmur, together with a slight systolic murmur at the aortic cartilage. There was no noteworthy enlargement of the heart, and there had never been loss of compensation. The abdomen was rather large, flabby, and fat, with thin muscular walls, and in the erect posture was somewhat pendulous. The patient objected to having an x-ray picture taken to ascertain the exact position of the stomach and large bowel, but the evidence was all in favor of some ptosis of both organs.

Her bowels had always been freely open at least twice daily, and often moved three times. Her blood pressure was 175 systolic and 75 diastolic, by auscultation. The blood and urine were negative, and a careful examination of the ears, nose, and throat by Dr. George Stout revealed no focus of infection. The accompanying picture (Fig. 1) shows the bony changes in the finger joints, characteristic of well-marked atrophic and hypertrophic arthritis. The patient had always had a good appetite and had eaten generously of everything, though not to excess, and was not in the habit of using alcohol in any form.

On January 27 she was instructed to eat meat but once a day, to stop her tea and coffee, to drink four glasses of water in addition to the fluid at meals, and was given daily four glasses of buttermilk prepared by artificial lactic acid fermentation.[2] Her usual diet was reduced over a period of about a week until the daily regimen was about as follows:

One glass of water on rising. Breakfast, consisting of a small amount of cereal, with cream and sugar, and one or two slices of well-done toast, with butter, hot drink (imitation cereal coffee, any of several varieties on the market) with cream and sugar if desired.

Between breakfast and lunch: Two glasses of "buttermilk" and one glass of water.

Lunch: Clear soup (or lettuce or spinach), one roast potato, toast (two slices), imitation coffee.

Between lunch and dinner: One glass of "buttermilk" and one glass of water.

Dinner: Clear soup (or twice a week a small amount of roast chicken, or twice a week 1 egg), toast or lettuce, imitation coffee, apple sauce.

Between dinner and bedtime: One glass of "buttermilk" and one glass of water.

Every afternoon about 5 P.M. the patient was given a simple enema and then high colonic lavage, with about 1½ quarts of normal salt solution, the washings being repeated until they came

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[2] The milk used was that marketed by the Supplee milk establishment under the trade name "Fermillac." Its approximate composition is given by the manufacturer as 3.6 per cent. fat, 5 per cent. sugar, 3.2. per cent. proteid, 0.8 per cent. lactic acid. It is a fairly constant product, free from lumps, and for the most part of uniform consistency, though at times, probably from unduly prolonged fermentation, it is somewhat "coppery" and disagreeably acid. Patients were told to avoid it under these circumstances. They all professed to like milk prepared this way and seemed not to tire of it. There are several equally desirable artificially soured milk products on the Philadelphia market. They differ from buttermilk in that the fat is not removed.

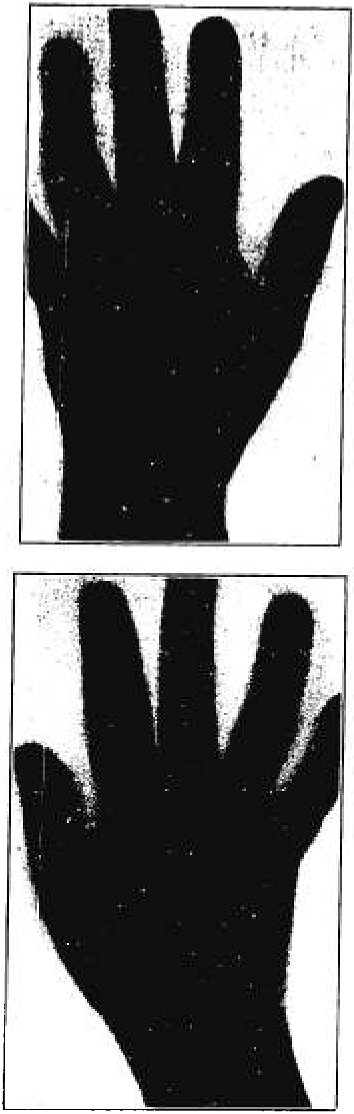

Fig. 1.—*X*-ray of hands of Case I, showing degree of joint involvement.

away fairly clear. Her bowels moved naturally in the morning. Later she preferred the injection in the morning about 10 o'clock, and was then given a glycerin suppository at bedtime, always with result. The injections were given daily from January 30 to April 24, on alternate days from April 24 to May 6, thence every third day for two weeks, and then discontinued. Great care was exercised, of course, to avoid the slightest pain or local irritation in their administration.

The progress of her case is interesting and as follows, from notes taken at the time:

January 26. Treatment started. Weight, 167½ pounds.

February 2. Feels distinctly brighter and fingers are smaller.

February 8. Much better.

February 10. Weight, 163½ pounds. Pain in knee less.

February 14. Weight, 163½ pounds. Fingers are less swollen than at any time yet. A ring which could previously be removed with great difficulty or not at all now comes off with relative ease.

February 25. Weight, 164½ pounds. Condition good.

March 16. Weight, 162½. Blood pressure: 156 systolic, 75 diastolic, ausculatory. Before instituting treatment it was 175 systolic, and 75 diastolic.

April 29. Weight, 162. Blood pressure: 158 systolic, 85 diastolic. Practically free from subjective and objective symptoms.

Further notes on this point are unnecessary as her condition was excellent and remained so all summer, despite the fact that for two months she lived at hotels and allowed herself much liberty in her diet. For one month she stopped the buttermilk entirely, retaining, however, her increased fluid intake and eating with moderation of meats and starches. About four months later, however, she appeared again for treatment.

As the result of the excitement of Christmas and the visits of some friends, as well, perhaps, because of deliberate intent, she began to eat more freely of puddings, rice pudding especially, and the so-called "simple desserts." On January 28 she weighed 157 pounds 3 ounces, and presented distinct pain and swelling in the ring finger of the left hand. She had of her own accord renewed the "buttermilk" in October, and was taking in January four glasses daily. She was then advised to stop all meat and starches except zweibach, to increase the milk by two glasses daily, and to rest more. She developed three days later bronchitis, with slight fever, cough, and coryza, but at the same time her fingers improved.

On February 15 she was given a squab for lunch, and from then on her diet was increased until at the end of March it averaged as follows:

Breakfast: Cereal with cream and sugar, toast, imitation coffee, with cream and sugar.

Lunch: Spinach, toast, "coffee."

Dinner: Roast chicken, roast potato, toast, "demi-tasse" of "coffee."

In addition to the above she had her usual amount of "buttermilk," four glasses daily, as above described.

The patient was perfectly content with this diet. By this time she felt well and was free from all joint manifestations. A short but sharp diarrhea during the attack of bronchitis had pulled down her weight, which recovered somewhat, and stood on March 25 at 151½ pounds. By April 18, however, she expressed herself as having never felt better, weighed 154¼ pounds, and was taking a practically unrestricted diet of everything that came to table, with the exception of obviously indigestible articles like corn and griddle cakes; the "buttermilk" had been reduced to four glasses daily. This served to lessen her appetite at table and reduced consequently the amount which she would otherwise have eaten. Though previously a large eater of meat she was now satisfied with smaller amounts. It is interesting to note that at the time of her relapse she had increased her usual dietary by starches and sugars only, and had taken no more animal proteid of any kind. Upon reducing these again and with her return to health her tongue changed its charter from being quite heavily furred and white to a nearly clear red. This excited her comment and was unique with her except for the periods of convalescence above mentioned.

Experience with this case determined the writer to pursue the subject in other individuals, more carefully and with laboratory methods.

The following represents the first attempt to that end.

Case II.—John H,. aged fifty-six years, a carpenter by trade, had suffered for five years past with increasing involvement of most of the fingers of both hands, both knees, especially the right, and the left foot. He also complained of stiffness and pain in his shoulders. His previous medical history was negative except for an attack of what resembled malaria and for the loss of one eye by accident eighteen years before. He had always been a great sufferer from constipation, and on occasion his bowels would not move for eight days. He denied alcoholic and venereal history, and was the father of several healthy children.

Examinations showed a spare man of middle height. Thorax and abdomen essentially negative, except for a palpable right kidney. Both hands showed extensive involvement, with marked deformity of the two middle fingers of the left hand. These were subluxated at the first phalangeal joint and presented distinct effusion.

The left knee was somewhat swollen, but the right foot was the part worst affected. It was swollen on the dorsal surface and pitted on pressure. There was no deformity of the toes, but pressure below and anterior to the external malleolus, in fact most anywhere, gave much pain.

His weight was 115 pounds; blood pressure, 105 systolic and 52 diastolic. His blood count averaged: Red blood corpuscles, 3,130,000; leukocytes, 13,500 to 7000; hemoglobin, 70 per cent. An *x*-ray taken by means of bismuth showed that the stomach and colon were in the normal position and gave no clue as to the cause of his constipation.

This was deemed a good case in which not only to try the therapeutic effect of the diet described above, but also to attempt metabolic study, etc., of his condition before and after improvement, should this occur. To this end he was placed upon the following average diet:

December 27, 1911. Breakfast: Bread, 60 grams; two eggs, 89 grams; butter, 23 grams; milk, 256 c.c.; water, two glasses.

Dinner: Bread, 60 grams; rice, 41 grams; apple sauce, 127 grams; butter, 18 grams; milk, 256 c.c.; water, 1 glass.

Supper: Bread, 55 grams; two eggs, 90 grams; butter, 17.5 grams; milk, 256 c.c.

This diet varied slightly on different days according to the size and weight of the eggs, etc., but the amounts taken on the various days are omitted to save space. The sum total of ingested food appears in the accompanying tables.

Metabolic observations were conducted for four days on the following: Nitrogen of the urine, ammonia of the urine, creatinin of the urine, nitrogen of the feces, total sulphates of the urine, preformed sulphates of the urine, ethereal sulphates of the urine, total number of bacteria in the feces.

The methods employed were as follows: Nitrogen, Kjeldahl method; ammonia, Folin's method; creatinin, Folin's method.

The sulphates were precipitated with $BaCl_2$ and calculated as SO_3.

The determination of the fecal bacteria was by counting, and will be discussed and described under Case III. The results of the latter in this case were unsatisfactory.

The figures obtained from the analysis in Case II were as follows:

	December 28	December 29	December 30	December 31
Nitrogen of urine . .	14.3942 grams	11.2 grams	8.624 grams	8.1984 grams
Ammonia of urine .	.3745 grams	.1632 grams	.1904 grams	.3917 grams
Creatinin of urine .	1.1984 grams	1.009 grams	1.0057 grams	.8872 grams
Ethereal sulphates .	....	.1419 grams	.1579 grams	.3694 grams
Preformed sulphates .	....	....	2.1249 grams	
Total sulphates . .	....	....	2.2828 grams	

Total nitrogen of the urine	42.4166 grams
Total nitrogen of the feces	2.6289 grams
Total nitrogen egested	45.0455 grams

Total food ingested: Bread, 756 grams; eggs, 726.5 grams; butter, 219.5 grams; milk, 2834 c.c.; rice, 152 grams; apple sauce, 559 grams.

Total nitrogen ingested, 42.5695 grams. *Negative* nitrogen balance, 2.4760 grams. Comment on these figures will be made later.

This patient on January 2, 1912, was put upon a diet of "buttermilk," eight glasses in twenty-four hours, together with one egg at breakfast, one green vegetable at lunch, apple sauce at supper time. Later he was given one bowl of hot strained clear soup at lunch, as he suffered much from the cold weather and cold dietary. Because of his undernutrition it was thought well to push his diet as much as possible, and he was given on January 18, a total of ten glasses of "buttermilk." An effort was made to keep him out of doors in a chair, but he complained so from cold that this was discontinued. He was also given daily in the morning a simple enema, followed by high colonic lavage, with about two quarts of warm normal salt solution. In the early evening he was given a glycerin suppository, which was, however, invariably ineffectual. The enema usually gave some result, generally slight, and his bowels could not be said to move with much satisfaction.

The following notes show such progress as he made:

January 9. The swollen finger-joint (with effusion) shows slight improvement; foot no worse. Patient discouraged. Has been on diet about a week.

January 11. Slightly better. Finger-joint is smaller, with less effusion.

January 15. Distinctly better today for the first time. Swelling in foot is less. Complains of some pain in leg muscles.

January 16. Improves.

January 18. Still better. Right knee slightly swollen, probably from increased activity. Swelling of right leg below the knee has now practically all gone; took ten glasses of "buttermilk" in all today.

January 19. Both foot and knee better. Weight, 112½ pounds. Swelling of foot practically gone.

January 28. Slight swelling of foot today. Nails very blue after being out in the cold air. Two more glasses of "buttermilk" to be given daily.

January 30. Foot still swollen in afternoon and somewhat so at other times of day, but much less painful—in fact, almost free from pain.

From this date on there was very little appreciable change in the man's condition. The swelling of his finger had subsided not to return, his general health was better, the pain in his foot was so diminished that he could at times walk with relative ease, but the edema of this one foot persisted, and he complained of pain in his shoulders, which kept him awake at night.

It had been the hope of the writer that at about this date or later another period of metabolic study could be undertaken, with the idea of comparing the various findings during improvement with those of the first period. The patient's condition, however, did not warrant the attempt, as he had not sufficiently improved. After a few weeks spent in the hospital he became restless, and was discharged at his own request.

In retrospect several errors can be detected in the attempt made with this case. The patient's general health had been so undermined, his constipation was of such an obstinate and long-standing nature, and he had such a marked anemia that a mistake was made in putting to the test with him any therapy without first relieving or modifying these conditions.

It was not desirable to cloud the issue by the simultaneous exhibition of iron, aresnic, etc., especially since metabolic observations were contemplated; but his anemia should have been actively treated, his constipation combated, and his weight increased if possible before the therapeutic test of his joint condition by means of dietary measures.

It is but just to say, furthermore, that this patient had been through half a dozen "cures" in this country and had tried many other treatments without avail. By the time that the arrest in his improvement became clearly evident, he grew restless, as mentioned, and desired to leave the hospital.

Furthermore, he required a degree of personal care in the way of massage and alcohol rubs to induce sleep, etc., which could hardly be administered with success in the public wards of a hospital, but he was of the opinion, judging by his own subjective experiences, that dietary regimen offered the only prospect of relief.

CASE III.—The next case studied was of greater interest possibly and gave much more encouraging results. The patient was a woman, aged thirty-seven years, who was deliberately chosen by the writer and asked to submit herself to treatment because of two facts: (1) She presented an unusually typical case of atrophic arthritis, of nine years' standing, in a young woman without other disturbances of health. (2) She had tried nearly every known treatment in a long series of hospital readmissions, during which she had been under the observation and care of at least nine careful clinicians. It was felt that success and study in her case would be especially satisfactory because of both the well-marked and progressive nature of her condition and the clear failure of other means of treatment. The essentials of her history, etc., were as follows:

Mrs. F., aged thirty-seven years, white, presented a negative family history and had always been healthy until the onset of the present trouble. She had one healthy child, aged twelve years. In December, 1903, she was operated upon at the German Hospital, Philadelphia, for appendicitis by Dr. John B. Deaver, and made an uneventful recovery, except for long-continued drainage of the abdomen. Three months later, after returning to her duties, she noticed an ephemeral and shifting stiffness of various joints accompanied by transient swelling. One year later this had resulted in a chronic swelling and disability of the middle finger of her left hand. From this time she progressed steadily from bad to worse. Because of the arthritis she was admitted three times to the Hospital of the University of Pennsylvania for periods of six months, five weeks, and four months respectively, and while there had her tonsils removed and a rectocele repaired. She was also treated for a temporary cystitis of origin subsequent to her joint trouble. She was also admitted three times to St. Timothy's Hospital, Roxborough, for periods of three days, seven weeks, and two weeks respectively, where she had some further remaining tonsillar tissue removed. Apart from this she had been under private professional care on many occasions.

Aspirin usually gave her relief from pain, but for a few hours only, and the one other measure of any avail was thyroid extract. This was administered during one of her periods at the University Hospital, with relief for some months, when she relapsed worse than ever. A second administration of the same drug at St. Timothy's Hospital was not only without benefit to her joints, but seemed to make them worse, and resulted in tachycardia and other symptoms of hyperthyroidism.

On the present admission she presented swelling, subluxation, hyperextension, atrophy, pain, limitation of flexion, and ulnar deviation of the fingers of both hands. There was also marked involvement of the elbows and of both knees, especially the right, which was swollen and partially ankylosed in slight flexion. The left ankle also presented marked swelling and pain below and external to the external malleolus, which was hidden by the tumefaction. She could barely use her hands to write, and she could not bear her full weight on either knee or ankle, much less walk. She was confined to bed and required assistance in caring for herself even in bed.

Her physical examination was negative in other respects, except for considerable corpulence, chiefly of the past year's duration, a large relaxed abdomen, and the fact that an x-ray photograph by Dr. W. S. Newcomet showed marked ptosis of the transverse colon, with sharp angles at the hepatic and splenic flexures.

The x-ray photographs of her hands showed a well-marked atrophic arthritis, with relatively little deformity, but marked rarefaction of the heads of the bones and almost total absence of

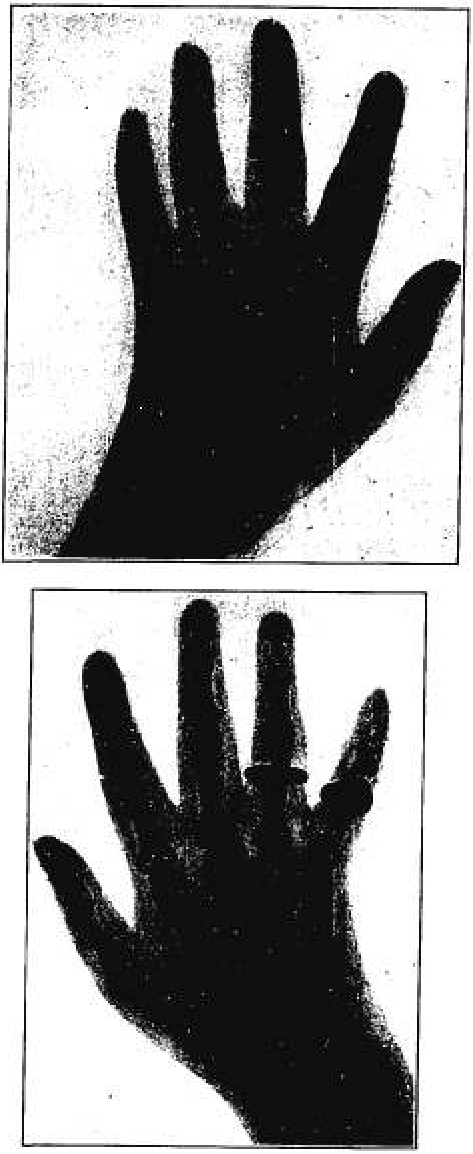

FIG. 2.—*X*-ray of hands of Case III, showing degree of joint involvement. The reproduction imperfectly illustrates the atrophic nature of the arthritis.

intra-articular cartilage. The plate of the right knee showed effusion and that of the foot some subluxation, in addition to the other characteristic phenomena of atrophic arthritis (Fig. 2).

The attempt was then made as with Case II, but here carried further, of placing the patient upon an average known diet, of no particular therapeutic value, in order to determine her metabolism while the diseased process was active. She was then placed upon the modified diet, and when improvement was sufficiently advanced another series of metabolic determinations was made. The results of these attempts follow.

On January 23, 1912, she was given the following average meals as the dietary of her first metabolic period and was kept in bed:

Breakfast: Bread, 47 grams; milk, 210 c.c.; one egg, 56.5 grams; water, 200 c.c.; butter, 13.5 grams.

Dinner: Bread, 27 grams; butter, 13.5 grams; milk, 300 c.c.; rice, 42 grams; sugar, 13 grams.

Supper: Bread, 42.5 grams; milk, 220 c.c.; one egg, 44.5 grams; water, 220 c.c.; butter, 13.5 grams.

The exact quantity of ingested food is tabulated later.

After she had been on this diet for three days her metabolism was studied with respect to the following: Nitrogen of the urine, ammonia of the urine, creatinin of the urine, ethereal sulphates of the urine, preformed sulphates of the urine, total sulphates of the urine, nitrogen of the feces, total number of fecal bacteria.

The figures follow:

	January 27	January 28	January 29	January 30
Quantity of urine . .	1016 c.c.	1030 c.c.	940 c.c.	760 c.c.
Nitrogen of the urine .	9.5750 grams	7.4466 grams	8.5660 grams	10.1360 grams
Ammonia of the urine .	.3713 grams	.2570 grams	.2856 grams	.3536 grams
Creatinin of urine . .	.9804 grams	.7896 grams	.9490 grams	1.0830 grams
Ethereal sulphates of urine	.3673 grams	.3865 grams	.3557 grams	.4124 grams
Preformed sulphates of urine	....	2.0262 grams	3.1260 grams	2.1913 grams
Total sulphates of urine	....	2.4127 grams	3.4817 grams	2.6037 grams

Total nitrogen of the urine	35.7242 grams
Total nitrogen of the feces	1.1718 grams
Total nitrogen egested	36.8960 grams

Total number of bacteria eliminated in four days by bowel, 373,750,000,000.

The total food ingested was as follows: Bread, 469 grams; butter, 160 grams; eggs, 405 grams; milk, 3530 c.c., rice, 108.4 grams; sugar, 52.5 grams; which yielded 36.266 grams nitrogen ingested. Negative nitrogen balance, 0.530 grams nitrogen. Her weight remained about 163 pounds.

On the completion of the above observations she was placed upon the following regimen:

Breakfast: Two glasses "buttermilk," one slice of toast and butter.

10.00 A.M. Enema of salt solution followed by colonic irrigation.

11.00 A.M. One glass "buttermilk."

12.30 P.M. Lunch of one glass "buttermilk," one green vegetable (spinach, lettuce, onions, cabbage).

3.00 P.M. One glass of "buttermilk."

5.00 P.M. Supper: Two glasses of "buttermilk," one slice toast and butter, one saucer apple sauce or stewed pears (not very sweet).

8.00 P.M. One glass of "buttermilk."

Water *ad libitum*, but she took very little.

The notes of her condition follow:

February 1. Diet started.

February 5. No indican, which had previously been abundant. Has a slight cold. No acetone. This was watched because of the reduction in the carbohydrates.

February 8. Hands seem much better. Gain of one-half pound in weight—now 159 pounds. Patient shows an unmistakable change since her new diet. Urine somewhat cloudy and shows white blood cells.

February 9. Hands slightly more tender in a few finger-joints, but no more swelling. No indican.

February 10. Doing well. Swelling of dorsum and of metacarpophalangeal articulations decreasing daily. Dimples begin to show over joint sites. Lost one pound.

February 12. Doing well.

February 13. Better. She is usually worse for one week prior to her menstrual period, but has escaped this time, though it is due tomorrow. This is her first experience of this. She says she moves better in bed and does not waken so stiff. Considerable indican today, probably referable to her period.

February 14. Menstruating. Slight soreness of hands. Possibly slight "cold" also.

February 22. No indican. Doing well.

February 27. Doing well and nearly free from pain on pressure over most joints or on motion of them. A ring which could not previously be removed without soap and water and much effort came off with relative ease for the first time.

February 28. Now getting the following average diet:

6.00 A.M. One glass of "buttermilk."

Breakfast: One glass of "buttermilk;" toast, 26 grams; butter, 6 grams;

10.00 A.M. One glass of "buttermilk."

12.00 N. Dinner: Lettuce and salt, 24 grams; one glass of "buttermilk."

2.00 P.M. One glass of "buttermilk."

4.00 P.M. One glass of "buttermilk."

6.00 P.M. Supper: Apple sauce, 172 grams; toast, 24 grams; butter, 5 grams.

8.00 P.M. One glass of "buttermilk."

9.00 P.M. One glass of "buttermilk."

Daily enema and colonic lavage still being administered. Weight, 159 pounds.

The patient had by now progressed so far that the second period of metabolic study seemed advisable.

Her diet was therefore carefully weighed and measured, the results of which in terms of total ingested food for the period follow.

The figures obtained from a four days' metabolic study while she was still in bed are:

	February 20	March 1	March 2	March 3
Quantity of urine . .	1930 c.c.	1650 c.c.	2130 c.c.	1350 c.c.
Nitrogen of urine . .	7.7280 grams	7.2990 grams	8.2544 grams	6.5856 grams
Ammonia of urine . .	.4896 grams	.3590 grams	.4488 grams	.3808 grams
Creatinin of urine . .	.8728 grams	.8969 grams	.9518 grams	.7042 grams
Ethereal sulphates of urine	.4884 grams	.4302 grams	.5251 grams	.3390 grams
Preformed sulphates of urine	2.0558 grams	2.1611 grams	2.0795 grams	1.4565 grams
Total sulphates of urine	2.5442 grams	2.5913 grams	2.6047 grams	1.7955 grams

Total nitrogen of the urine	29.8670 grams
Total nitrogen of the feces	2.8684 grams
Total nitrogen egested	32.7354 grams

Total number of fecal bacteria eliminated in four days, 12,372,000,000,000.

Total food ingested: Toast, 201 grams; butter, 46 grams; "buttermilk" or "Fermillac," 8192 c.c.; lettuce, 150.25 grams; apple sauce, 607 grams; apples, 438 grams; which yielded *in toto* 41.3554 grams nitrogen.

There was therefore a *positive* nitrogen balance of 8.62 grams.

Subsequent notes are as follows:

March 4. Slight "cold" possibly. No fever. Right hand and wrist slightly sore. Allowed up. Weight, 159 pounds. Out in chair on piazza. Out every day on piazza. Her ankle is now much less painful, as is also her right knee. Wants to get up and go home.

March 29. Slight pains today in one hand and right elbow, due to approaching menstruation, possibly, which sometimes comes slightly ahead.

March 31. Menstruating. Diet increased to a total of one egg and fruit at breakfast, one slice of toast at each meal, one vegetable and soup at lunch, two green vegetables and stewed fruit at supper, with usual amount of "buttermilk."

April 4. Taking increased diet well and is apparently cured of, all active processes in her hands. The only painful parts are in the right knee, where the disability is possibly mechanical, and to a slight extent in the malleolus. This may also be mechanical, as the *x*-rays show a subluxation in the foot. Weight, 157 pounds.

April 26. Diet has been increased and the "buttermilk" reduced to only five glasses daily. Now taking chicken and a roast potato at lunch in addition to the egg at breakfast and green vegetables at supper; also has ice cream at times. Took fish from another patient once without orders, but it did not hurt her. Has had massage and stretching of her slightly contractured right leg, which is now becoming straighter. Is up and around the ward a little every day, and says that her foot is nearly or entirely free from pain. Menstruating today, but has no exacerbation of any symptoms, as occurred prior to treatment.

Enough has been said of the course of this case to show that to all intents and purposes her inflammatory arthritis at this point had subsided. In conjunction with the case first cited and the previous history of the present case the results leave no room for doubt as to the importance of these measures in at least some instances.

METABOLIC FINDINGS. The metabolic figures of Case II are given for what they are worth, but since no control observations could be made during marked improvement their value is minimized. They show nothing that could not be encountered in health, though the ethereal sulphates are conspicuously low as compared with the next case, and, indeed, are low for any individual who suffers much from constipation.

Metabolic observations on such cases during the activity of disease are not lacking, but data on the relative proportions of the various factors then and during convalescence are rare.

Turning now to Case III a review of the figures is more profitable. In the first metabolic period we find an output of ammonia which is just about in accord with what is usual in health, though verging on an output actually low.

The creatinin is about normal, as it also was in Period II, and can be dismissed from further notice. It is evident, so far as the creatinin output can be taken as an index of general muscular metabolism, that internal muscular metabolism *per se* plays no important role in this condition.

Considering next the ethereal sulphates we find rather high values, which might be expected *a priori* perhaps, though they are not excessive. It is interesting to note in connection with the ethereal sulphates here and in the next period that "Keffir"[5] has been mentioned in doses from 1 to 1.5 liters a day as an excellent remedy with which to combat intestinal putrefaction.

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[5] Simon, Clinical Diagnosis, fifth ed., 408.

Comparing then the ethereal sulphates of Period I with those of Period II, there is found a surprising rise in the latter, when the patient was improving rapidly, associated with a decrease or absence of indican.

Whereas they had averaged in Period I about 0.3805 they rose in Period II to 0.4457, an increase of 17 per cent. The ratio of conjugate to preformed sulphates in the first period was 1 to 6.4; in the latter period it rose to 1 to 4.3 in spite of ample daily bowel movements and lavage of the colon.

The amount of nitrogen ingested was smaller and the amount of nitrogen egested was larger in Period I than in Period II.

It is hard to explain how the introduction of large amounts of lactic acid organisms can in any way have contributed to this increase of the ethereal sulphates, since they are supposed, as above cited, to lessen intestinal putrefaction.

The positive nitrogen balance, however, shows that the patient handled with success a larger amount of proteid in her second period, and this may have explained, notwithstanding the decreased nitrogen output, the increase noted.

If the conjugate sulphates be a true criterion of the so-called intestinal putrefaction, we must deduce that, in this case at least, intestinal putrefaction was not a serious etiological factor and the cause of disease must be sought elsewhere than in the putrefaction of proteids. As a matter of fact, the writer has been inclining to the view, to which this lends color, that an important noxious role is played here perhaps by the carbohydrates, particularly the starches. Other clinical evidence indicates much the same, and it can be shown in some of these patients that entire curtailment of proteid other than milk will not help them if they be fed generously with carbohydrates. In fact, as just shown, the proteid intake was actually increased in this present case, before and during the improvement. One case does not warrant postulates on this score, but it is at least suggestive.

It is interesting to note that in the patients who improved a great change appeared in their stools. For example, whereas Case I had had for perhaps forty years from two to five stools daily, of a frothy, loose nature, these became transformed after her new dietary into more mushy, semiformed or formed stools passed but once a day, unless a suppository was resorted to later. We have had the same experience in certain other cases where the carbohydrates were reduced, and there can be but little doubt that these were responsible for the change. There seems to be in this further suggestive association of the carbohydrates with conditions of the disease.

The ammonia in both metabolic periods of Case III was within reasonable limits, though it showed a rise from 3.4 per cent. of the urinary nitrogen in Period I to 5.6 per cent. of the urinary nitrogen in Period II. This can hardly be interpreted as implying more than would be expected in view of the considerable quantities of lactic acid consumed.

The preformed and total sulphates showed no marked change in the two periods, were of average amount, and interesting chiefly because of their relation to the conjugate sulphates.

We now approach the interesting though difficult question of the fecal bacteria. What role these play in normal physiology is by no means clear, to say nothing of their relation to diseased processes, but increasing investigations point to the desirability of further knowledge along this line, despite the technical difficulties presented. We are well aware of the skepticism with which this field is regarded, and of the fact that until our premises are more firmly established little that is dependable can be expected. It is equally clear, however, that more active effort should be made to utilize what is known, and the present case is an attempt at discovering a clue on which more elaborate work may be based.

It was desirable that bacteriological studies be undertaken in the present connection, but as this is a formidable undertaking, and was impracticable when contemplated, simpler methods were resorted to.

In feeding great numbers of organisms by the mouth, as is done with buttermilk, one would expect that they would reappear in the feces in equal or greater numbers; but this could not be postulated, least of all in the face of clinical improvement. One could not assume that a vast increase in the total number of bacteria within the gut, of whatever kind, could be beneficial or even harmless. It seemed interesting, therefore, to determine if possible what the facts might be in this regard.

Various methods have been advanced for the estimation of the fecal bacteria, but all of them are open to the criticism of inaccuracy.

Strasburger and Schmidt were among the pioneers in this work, but there is grave doubt whether their gravimetric method of centrifugalization or any of its later modifications is of any avail. It has met with disfavor at many hands, though championed by a few, the strongest of whom seem to be MacNeal, Latzer, and Kerr.[4] According to them it is possible by a most painstaking and laborious technique to obtain dependable results, but the present writer was forced by experience to the conclusion that any method which depends upon removal and estimation of the fecal bacteria by centrifugalization is unreliable.

MacNeal and others agree, however, that the method which admits of the nearest approach to accuracy is that of directly counting the organisms. Several modifications of this can be practised, the most available of which seems to be by mixing a known quantity of the properly diluted feces with a small amount of citrated normal blood, and, after agitating the whole, counting the ratio of organisms to red cells in a given stained smear. This gives an approximate idea of the number of organisms present, and while having little or no absolute value, is probably dependable in the same hands for relative values of wide variation.

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[4] Proc. Soc. Exp. Biol. and Med., New York, 1908-09, vi, 88 to 90.

The stools then when passed were at once covered with a solution of 0.5 per cent. HCl and thoroughly mixed to ensure contact of the acid with all parts. They were then sent to the laboratory and worked up as soon as practicable, generally within an hour. More acid of the same strengh was added to make a fairly liquid mass, which was then thoroughly rubbed up in a large mortar until of a uniform homogeneous consistency. This was further diluted if necessary, well mixed, then measured, mixed again, and a sample of 5 c.c. taken and diluted to 50 c.c., with the acid solution. A little of this mixture was drawn up in a small capillary tube. An equal amount of a mixture of normal human blood and sodium citrate was then drawn up into the same tube and the two solutions were mixed by blowing in and out on a glass slide. Smears were then made of this, fixed, and stained with Tiedmann's stain (methylene blue and eosin). A definite field of the slide was then chosen and a count made of 500 red blood cells and of the organisms in the same fields. Having used normal human blood with 5,000,000 red blood cells to the cubic millimeter, the proportion follows: 500 is to 5,000,000 as the number of organisms counted is to x, whence the final calculation is easily made.

By this means the total number of the bacteria of the stools for the first and the second periods were respectively as follows: Period I, 373,750,000,000; Period II, 12,372,000,000,000. This shows a marked increase in the total number in Period II. It was to be expected perhaps, and yet it could not be assumed until proved.

It is to be noted that the stools, in which the bacteria were counted in Period II, were natural or the result of an enema of salt solution, and did not represent colonic washings if they could be kept separate. It was evident before making the final calculation for dilution that in all cases the counts of bacteria were actually higher than in Period I. These counts were made by Dr. Glenn, resident pathologist of the Presbyterian Hospital, to whom the writer desires to express his indebtedness.

The true significance of this finding is not clear, since we know nothing of the types of organisms concerned.

It does seem reasonably apparent, however, that in joint conditions of this kind the mere presence of bacteria in greatly increased numbers within the bowel is not incompatible with improvement, and that these bacteria may play an important role to this end. Since the marked increase in the number of organisms is presumably due to the fermentative or lactic acid type the coincident increase of the ethereal sulphates is hard to explain, and lacking further data one can merely hypothesize. Further experiments are in progress, with the view of substantiating these observations and determining their significance.

SUMMARY. Summing up the general facts indicated by this as yet incomplete study, it is evident that certain joint cases which are rebellious to all other means of treatment, as proved by long trial, can be arrested by means of a proper dietary coupled with colonic lavage.

The dietary can be so greatly modified during the course of improvement as eventually to differ but slightly from that of a normal individual, and the lavage can be quickly dispensed with entirely.

Coincident with the improvement there may occur an increased output of ethereal sulphates and an increased output of fecal bacteria. The former of these is not out of consonance with the view suggested by certain clinical evidence that the carbohydrates are of hitherto unsuspected importance in this connection. The way is opened to more careful study along this line.

There can be no doubt that while the principles on which the above treatment is based are perhaps known to some, they are unfamiliar if not unknown to the vast body of clinicians who attempt the treatment of this omnipresent disease.

Furthermore, there can be no serious question that a definite proportion of these sufferers can be benefited if not cured in this manner, and it is not inconceivable that further study will show most of them to be in this category.

The adoption of these methods should not be attempted except in cases suitably prepared for it or in those free from demonstrably removable cause. These methods should be applied gradually, with due respect for the caloric needs of the individual, and with constant regard for the weight. Only the most painstaking attention to detail will ensure success, and carelessness during or after convalescence will induce relapse.

The careful study, metabolic and otherwise, of cases which improve under this regimen must yield data of real value in deciphering the factors causing joint disease and the means of removing them.

The data here cited seem to form a suggestive beginning.

In conclusion it is a duty and pleasure to express obligation in a number of directions: To the late Dr. John H. Musser, to Dr. S. S. Stryker, Dr. James E. Talley, and Dr. Edward H. Goodman for many courtesies shown in the wards of the hospital; to Dr. Damon B. Pfeiffer, director of the pathological laboratory, for his courteous and obliging coöperation under hampered conditions; to the Board of Managers of the Presbyterian Hospital for the installation of chemical equipment for clinical research; and finally to Dr. Joseph Sailer, through whose interest and coöperation primarily the facilities for the present study were made possible.